INTEGRATED
FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

COASTAL STORM DAMAGE REDUCTION

**BOGUE BANKS, CARTERET COUNTY**

**NORTH CAROLINA**

# APPENDIX I

# Parking and Access

**US Army Corps of Engineers**
**Wilmington District**

# 1.0 INTRODUCTION

The Army Corps of Engineers has several requirements that must be met in order to fully cost share in a coastal storm damage reduction project (see ER 1105-2-100 and ER 1165-2-130). These requirements include that the beaches must be available for public use and provide adequate parking and access. As described in ER 1165-2-130 (Federal Participation in Shore Protection, paragraph 6.h.), "Parking should be sufficient to accommodate the lesser of the peak hour demand or the beach capacity", and "public use is construed to be effectively limited to within one-quarter mile from available points of public access to any particular shore. In the event public access points are not within one-half mile of each other, either an item of local cooperation specifying such a requirement and public use throughout the project life must be included in the project recommendations or the cost sharing must be based on private use." The Corps' Wilmington District, additionally, has developed more specific public access and parking requirements for participation in coastal storm damage reduction projects within the District's boundaries of North Carolina and Virginia. The Wilmington District requirement requires that a minimum of 10 public parking spaces be located within one-quarter mile of a public access point. The criteria for 10 spaces was based on using an average lot size along the shoreline area and determining how many parking spaces could be provided in that lot size (e.g. a 50' x 95' lot size can provide 10 spaces).

This Appendix contains an analysis of the current parking and access situation at Bogue Banks and how it relates to the distribution and peak demand requirements. The local sponsor will need to address any parking and access deficiencies prior to the signing of the PPA, otherwise project cost sharing could be adjusted. If the required number of parking spaces cannot be obtained, in some cases a public transportation system adequate for the needs of projected beach users may suffice instead (see ER 1165-2-130, section 6h(2)). Recognizing that circumstances can change between the time that this initial analysis was done and the PPA is signed, the parking and access needs as presented in this Appendix may be revisited at some point prior to the PPA signing.

# 2.0 Data

The spatial analysis of available public access and parking within the project areas was conducted using the following data:

*Existing spatial data assembled for this analysis:*

- Public Beach Access 2004 – Source: State of North Carolina CAMA Office
- Carteret County Tax Parcels 2010 – Source Carteret County Tax Office

*New spatial data layers created for this analysis:*

- Beach Access ½ Mile Radius – ½ Mile Radius buffers were created from the Public Beach Access Points. These circles represent the maximum distance allowed between Public Beach Access Points.
- Access Distance Greater than ½ Mile – Line segments were created between each Public Access Point. Data layer contains a definition query limiting display to only those

segments that exceed ½ Mile, or the maximum distance allowed between Public Access facilities per USACE Policy.

- Town Properties – Properties owned by the towns were derived from the Carteret County Tax Parcel Data to illustrate where potential Public Beach Access may be obtained if needed.

# 3.0 BEACH ACCESS

## 3.1 Methodology

Public Access Points were compared to the Project Area. Those Public Access Points adjacent to the given Project Area were selected for further analysis. Circular buffers with ½ Mile radii were generated from the selected Public Access Points. These circular features were given the layer name "Beach Access ½ Mile Radius" and are depicted as hollow blue circles in Maps 1-9 (all maps are contained at the end of this Appendix). These features, originating at each Public Access Point, must intersect with a Public Access Point on both east and west sides to meet the required maximum distance between public access points per USACE Policy. Instances where Public Access fails to meet this requirement are found on Access Maps (Attachment 1) 1,2,5,6,7 and 8 within Emerald Isle, Indian Beach, Salter Path, Pine Knoll Shores, and Atlantic Beach.

Further analysis was conducted to determine the distance between those Public Beach Access Points that were more than ½ Mile apart. The line feature "Access Distance Greater than ½ Mile" was generated using the Public Beach Access Points. The lengths of these line segments were calculated and a definition query used to select those segments with a length exceeding ½ Mile. These selected lines were then labeled with their calculated lengths to illustrate the magnitude of public access deficiencies within the project areas.

## 3.2 Results

There are 98 existing access points distributed throughout the study area.

Maps 1 and 2 define four instances within Emerald Isle that fail to meet the USACE public access density requirement. The distance between Public Access points located Wyndtree and Randy's Way has been calculated as 1.16 Miles (see Map 1). To meet access density requirements, two additional Public Access Points are required between these two points. The distance between Public Access points located at Heavenly and Seagull has been calculated as 1.22 Miles (see Map 2). At least two additional Public Access Points are required between these two points to meet access density requirements.

Map 5 illustrates two instances of public beach access deficiency. The distance between the Indian Beach Regional Access and the Salter Path Regional Access has been calculated to be 0.58 Miles. Technically, to meet access density requirements, an additional Public Access is required between these two points. However, since this distance is within 500 Feet of the maximum allowable distance, USACE may consider a waiver for this segment of the project. The distance between Salter Path Regional Access and the Sea Plantation West Access has been calculated to be 0.59 Miles. Technically, to meet access density requirements, an additional

Public Access is required between these two points. However, since this distance is within 500 Feet of the maximum allowable distance, USACE may consider a waiver for this segment of the project.

There are three instances of Public Beach Access deficiency in Pine Knoll Shores on Map 6. The distance between the Trinity Center Regional Access and the Ramada Inn Regional Access has been calculated to be 1.14 miles. Two additional Public Beach Access points are required between these two points. The distance between the Ramada Inn Regional Access and the Iron Steamer Regional Access has been calculated to be 0.95 miles. One additional Public Beach Access is required between these two points.

Another three Public Beach Access deficiencies in Pine Knoll Shores can be found on Map 7. The distance between Iron Steamer Regional Access and memorial Park Regional Access has been calculated to be 1.33 Miles. Two additional Public Beach Access Points are required between these two points. The distance between Memorial Park Regional Access and the Amerisuites Regional Access has been calculated to be 1.02 Miles. One additional Public Beach Access is required between these two points to meet the minimum access requirement.

Map 8 shows the last three Public Beach Access deficiencies of the project in Atlantic Beach. The distance between the Sheraton East Regional Access and the Coral Bay Regional Access has been calculated to be 0.65 Miles. One additional Public Beach Access is required between these two points. The distance between the Coral Bay Regional Access and the Durham Street Regional Access has been calculated to be 1.34 Miles. Two additional Public Beach Access points are required between these two points.

In summary, at least 13 additional beach access points are needed throughout the project area to meet the USACE requirement for adequate distribution.

# 4.0 PARKING DISTRIBUTION

## 4.1 Methodology

Public Access Points and Parking Data were compared to the Project Areas. Those Public Access Points adjacent to the given Project Area were selected for further analysis. Circular buffers with ¼ Mile radii were generated from the selected Public Access Points. These circular features were given the layer name “Parking Radius ¼ Mile” and are depicted as hollow blue circles in Maps 1-9. These features, originating at each Public Access Point, must contain a minimum of 10 public parking spaces within ¼ Mile per USACE Policy. Instances where Public Access Parking fails to meet this requirement are found on Parking Maps (Attachment 2) 1, 2, 3, 4, 8, and 9.

## 4.2 Results

There are an estimated 1,832 existing parking spots distributed throughout the study area (including Fort Macon). Beach Access Points were symbolized with a Green Filled Circle where the number of parking spaces met or exceeded the minimum of 10 spaces. Beach Access Points

were symbolized with a Red Filled Circle where the number of parking spaces was less than the required 10 spaces. Each Beach Access was labeled with the number of known Parking Spaces.

The Beach Access Points Channel Drive, Inlet and Coast Guard Road, and Wyndtree are all within ¼ mile of each other. Each Access point in this group has 10 Parking Spaces within ¼ mile. None of the other Beach Access Points on Map 1 meet the minimum requirement for parking.

The Beach Access Points Western Regional Access and Janell are located within ¼ mile of each other and both have 10 or more parking spaces available within ¼ mile. No other Beach Access Points on Map 2 meet the minimum requirement for parking.

Only Beach Access Point Dog Leg meets the minimum requirement for parking on Map 3. Dog Leg is located within ¼ mile of Western Regional Access 2 and has access to 10 or more parking spaces.

On Map 4, Beach Access Points at Western Regional Access 2, 25$^{th}$, 5$^{th}$, 3$^{rd}$, and 2$^{nd}$ all have 10 Parking Spaces within ¼ mile. None of the other Beach Access Points on Map 4 meet the minimum requirement for parking.

All Beach Access Points on Map 5 meet minimum parking requirements. Beach Access 1$^{st}$, Baptist Church Gazebo, Ocean Club, Indian Beach Regional Access, Sea Plantation West, and Trinity Center Regional Access all meet the minimum parking requirements with access to 10 or parking spaces within ¼ mile.

Map 5 illustrates Beach Access Points at Salter Path Regional Access and Trinity Center Regional Access both meet or exceed the minimum parking requirement. No other Beach Access Points on Map 5 meet the minimum requirement for parking.

The Ramada Inn Regional Access and Iron Steamer Regional Access located on Map 6 both meet or exceed the minimum parking requirement.

The memorial Park Regional Access and the Amerisuites Regional Access on Map 7 meet the minimum requirement for parking, along with the Iron Steamer Regional Access also visible on Map 7. However, the Sheraton West Regional Access does not meet minimum parking requirements.

On Map 8, Durham Street Regional Access, Charlotte Avenue Regional Access, Raleigh Avenue Regional Access, Bath House Regional Access, The Circle Regional Access and Beaufort Avenue Regional Access all meet the minimum parking requirements by having 10 available parking spaces within ¼ mile.

New Bern Street Regional Access and Club Colony Drive Regional Access both meet required minimum of 10 Parking Spaces within ¼ mile. None of the other Beach Access Points on Map 9 meet the minimum requirement for parking.

# 4.0 PEAK PARKING

A study/survey was conducted by the University of North Carolina at Wilmington (UNCW) in 2003 was used as the basis for estimating potential peak hour parking demand in the area (this study can be made available upon request) at the time a project is constructed (currently estimated to be 2019 for the Bogue Banks Project). Peak hour demand is defined here as the average number of non-overnight visitors at the beaches at 1 p.m. on July 4, 5, 12, 13 and Aug 2, 3, 9, 10, 30, and 31. Sufficient parking capacity is defined here as having enough parking spaces to accommodate peak hour demand on 60% of peak days. This means that on average, there would be enough public parking to accommodate all beach visitors year round, with the exception of at peak hour (1 p.m.) on four of the busiest (peak) days of the year.

The increase in peak demand is based on increases to the width of the beach. Because beach width will vary over the life of the project, an average annual change in beach width between the with and without project condition was calculated. This difference in beach width was measured for each of the individual towns in the project area (Emerald Isle, Indian Beach, Salter Path, Pine Knoll Shores, and Atlantic Beach) and used as the basis for determining project recreation benefits (see Appendix B – Economics) and the peak hour parking demand in each of these towns with a project in place in 2019. The methodology for determining the number of required spaces is included as Attachment 3 to this Appendix. The number of parking spaces required to meet the peak hour parking demand requirement, as well as the current number of parking spaces in each of the towns is shown in Table 1 below.

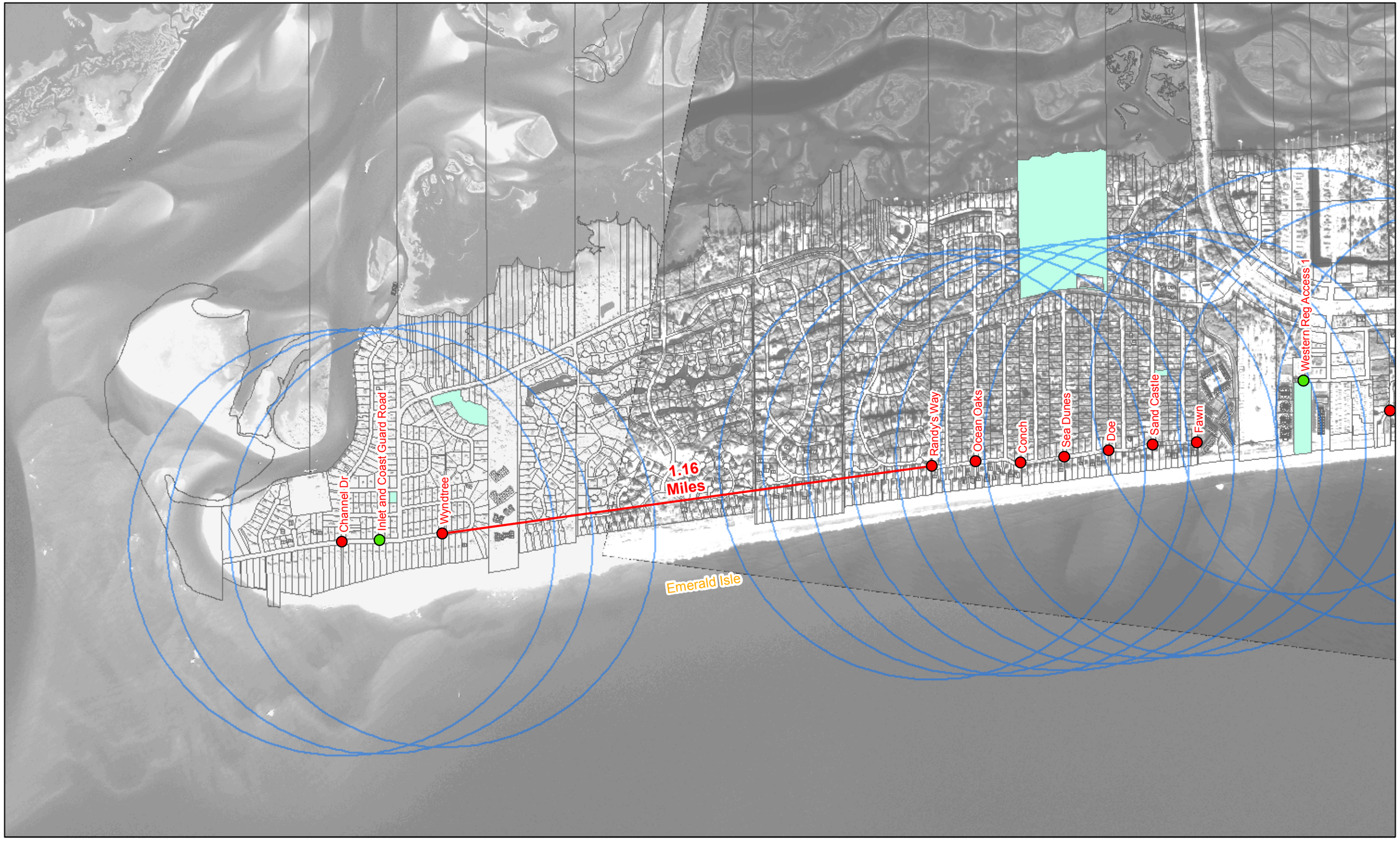
| Town | Total Parking Spaces Needed | Current Parking Spaces |
|---|---|---|
| Emerald Isle | 662 | 525 |
| Salter Path/Indian Beach | 96 | 141 |
| Pine Knoll Shores | 210 | 155 |
| Atlantic Beach | 2,303 | 1,011* |
| **Total** | **3,271** | **1,832** |

*Includes parking spots available at Fort Macon State Park

Table 1. Number of parking spaces needed to meet peak parking requirement, and estimated number of current parking spaces.

# ATTACHMENT 1

# PUBLIC ACCESS MAPS




U.S. Army Corps of Engineers
Wilmington District

Bogue Banks
Beach Access/Parking Assessment

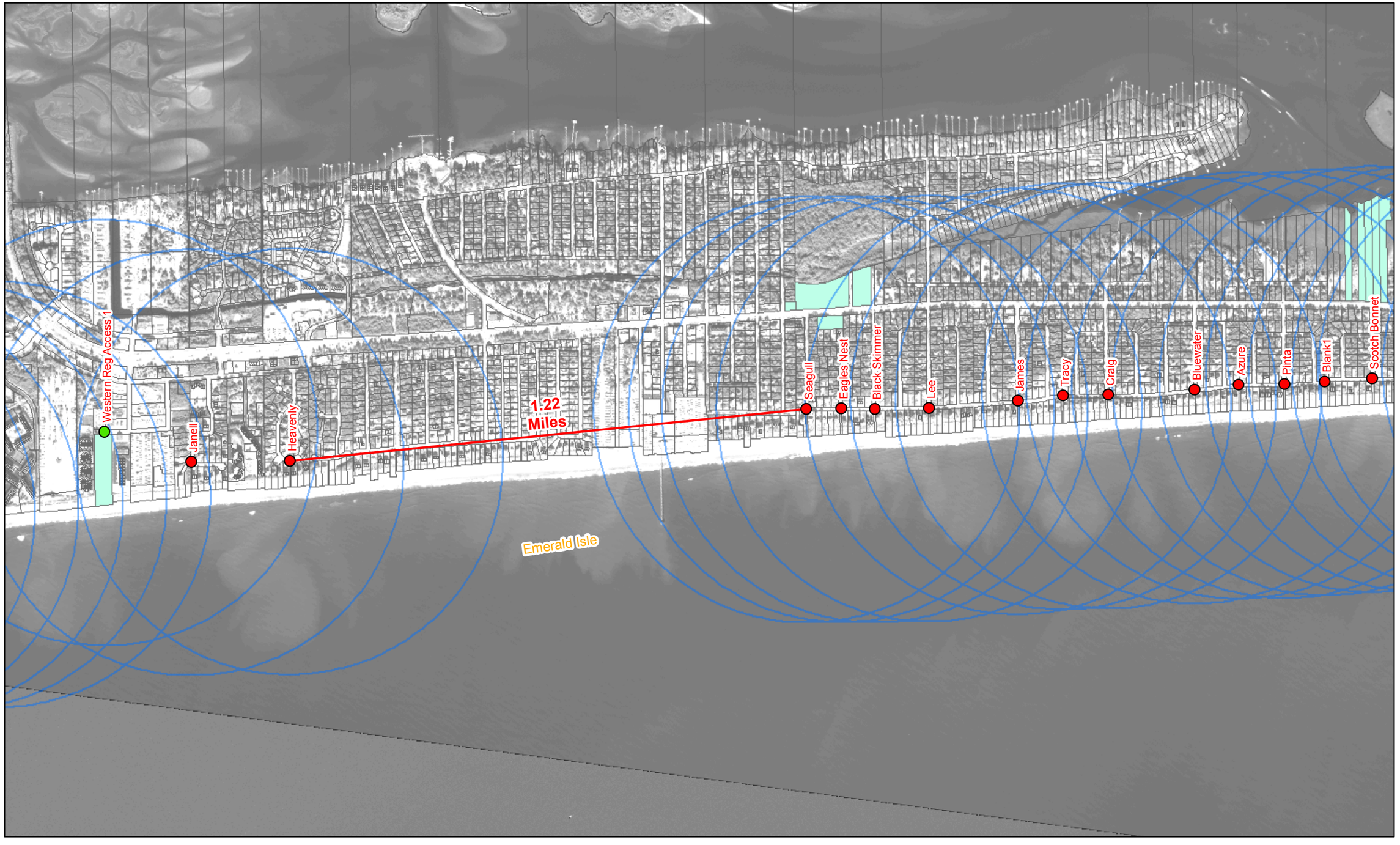


1 inch = 1,149 feet

1,000 500 0 1,000 Feet

**Legend**

**Beach Access/Parking Spaces**
- Less Than 10 Parking Spaces
- 10 or More Parking Spaces
- Access Distance > 1/2 Mile
- Beach Access 1/2 Mile Radius
- Town Properties
- Carteret Tax Parcels 2010




U.S. Army Corps of Engineers
Wilmington District

Bogue Banks
Beach Access/Parking Assessment

Imagery: Copyright 2011 DigitalGlobe Inc.

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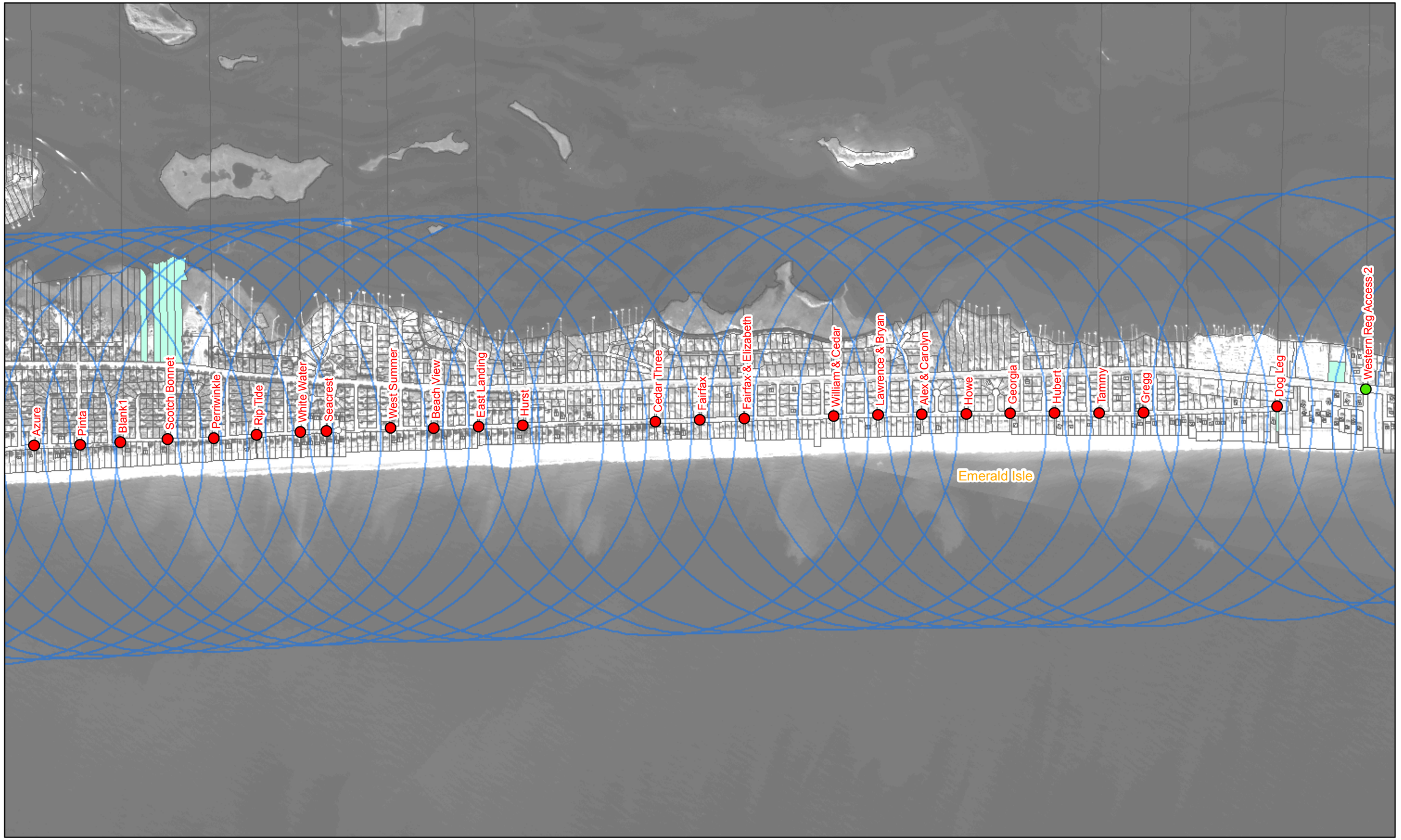


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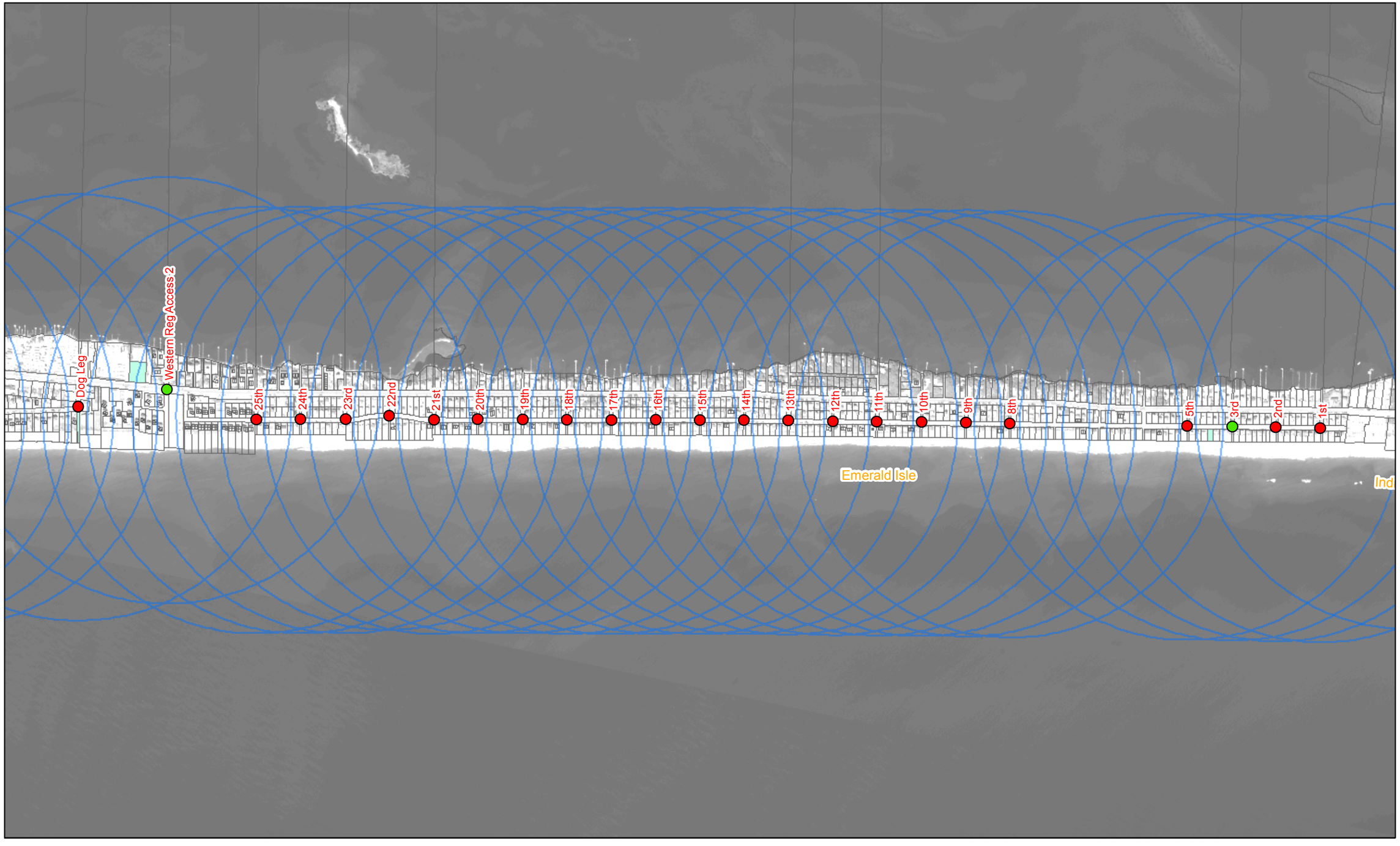


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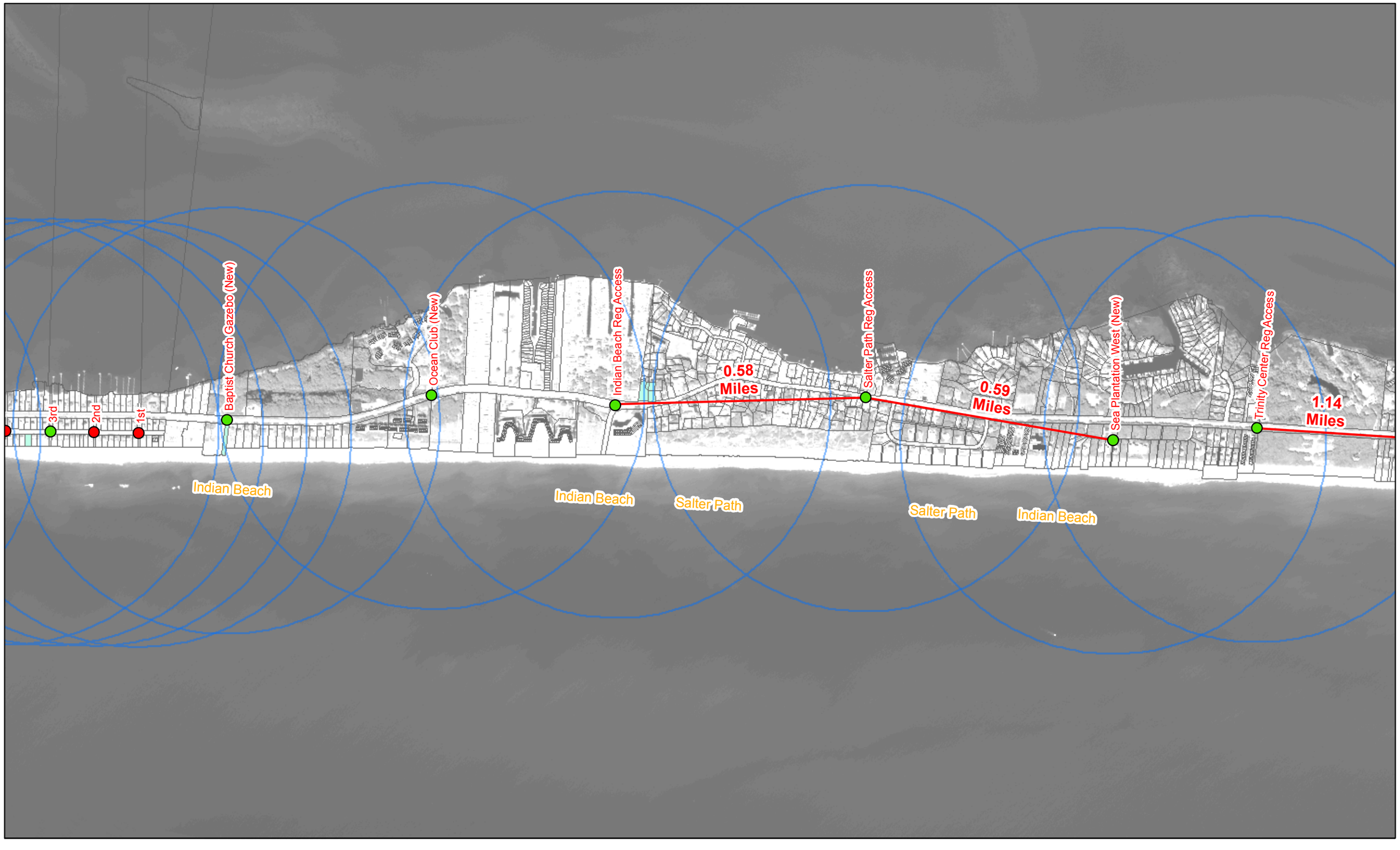


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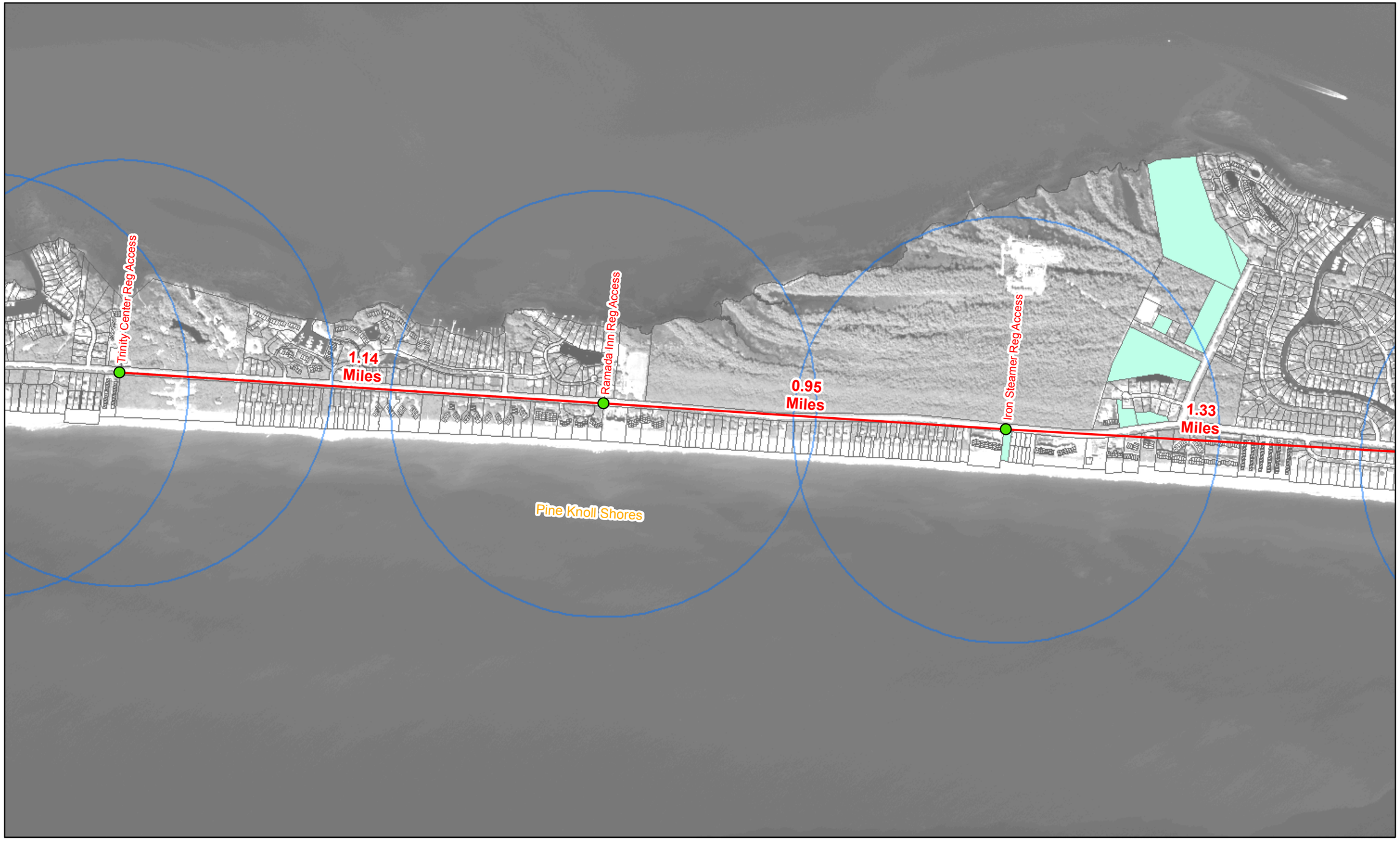


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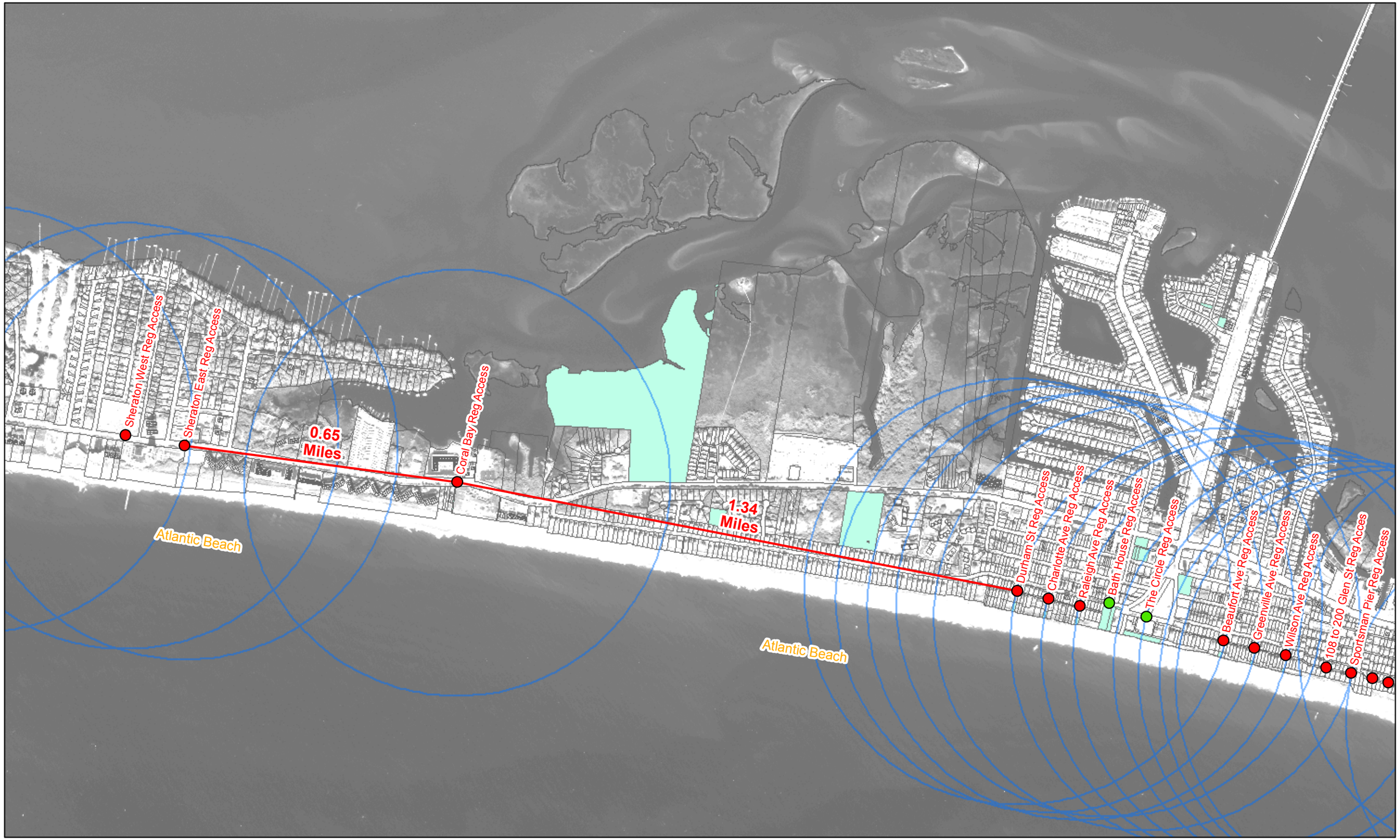


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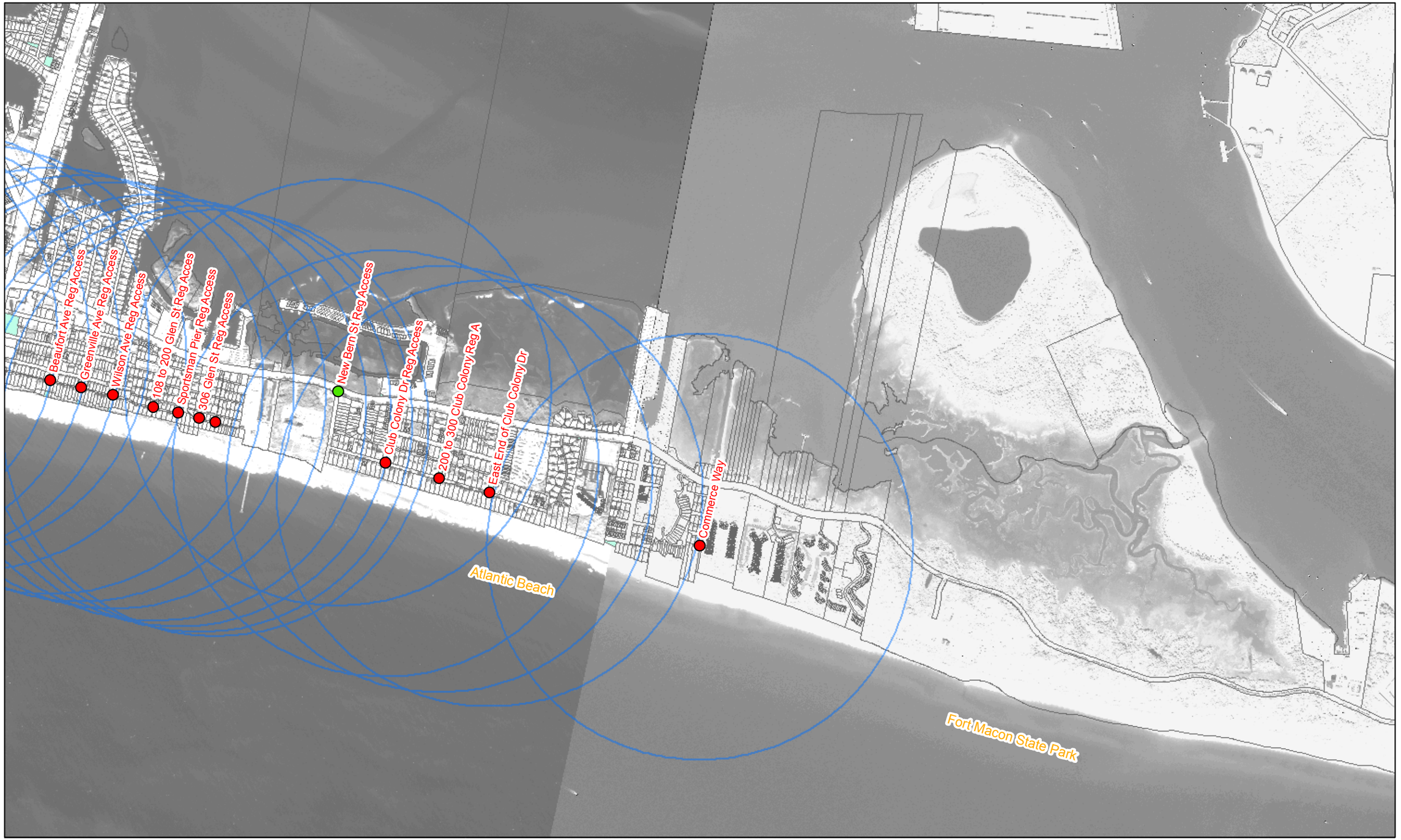


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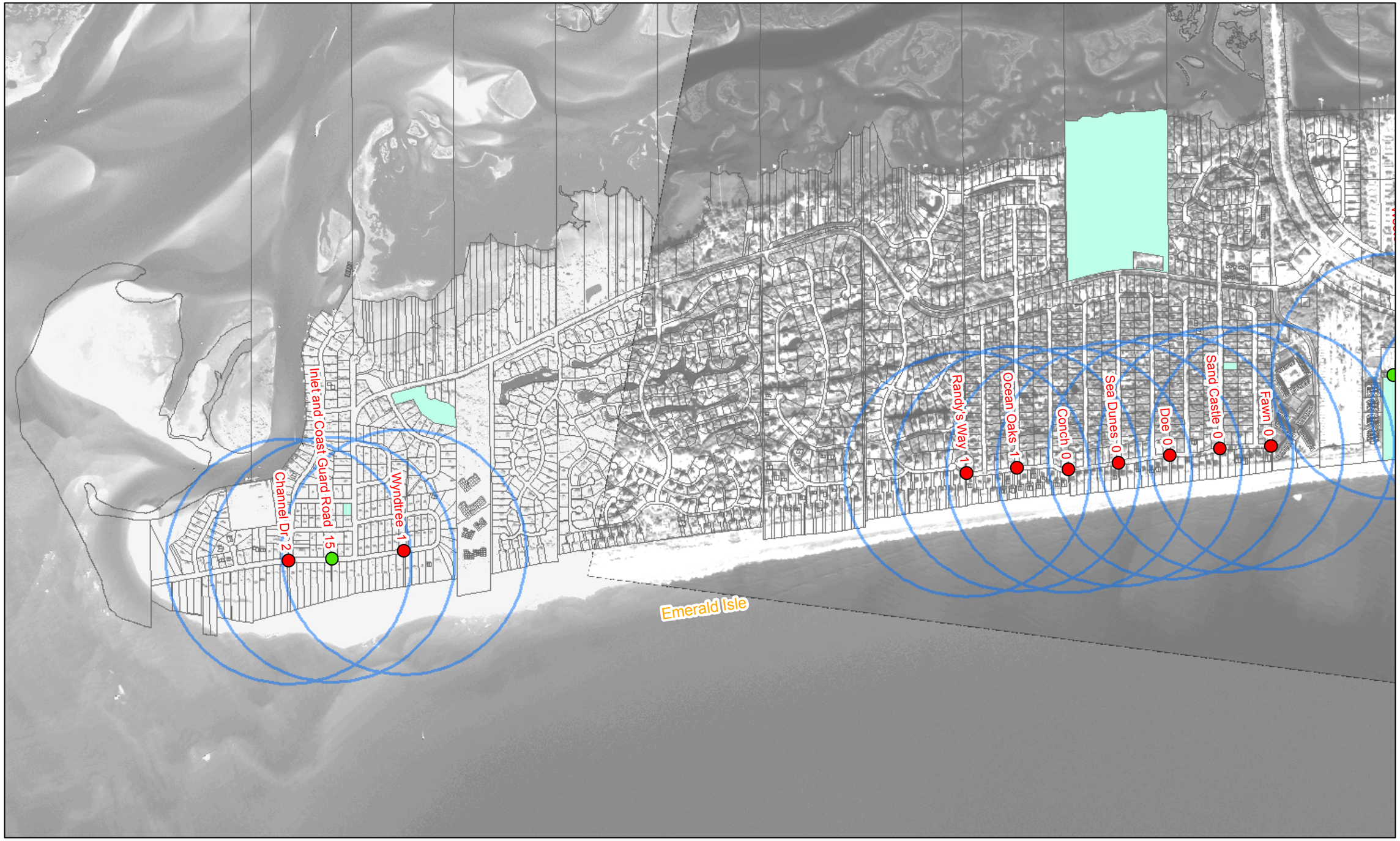
# ATTACHMENT 2

# PARKING DISTRIBUTION MAPS

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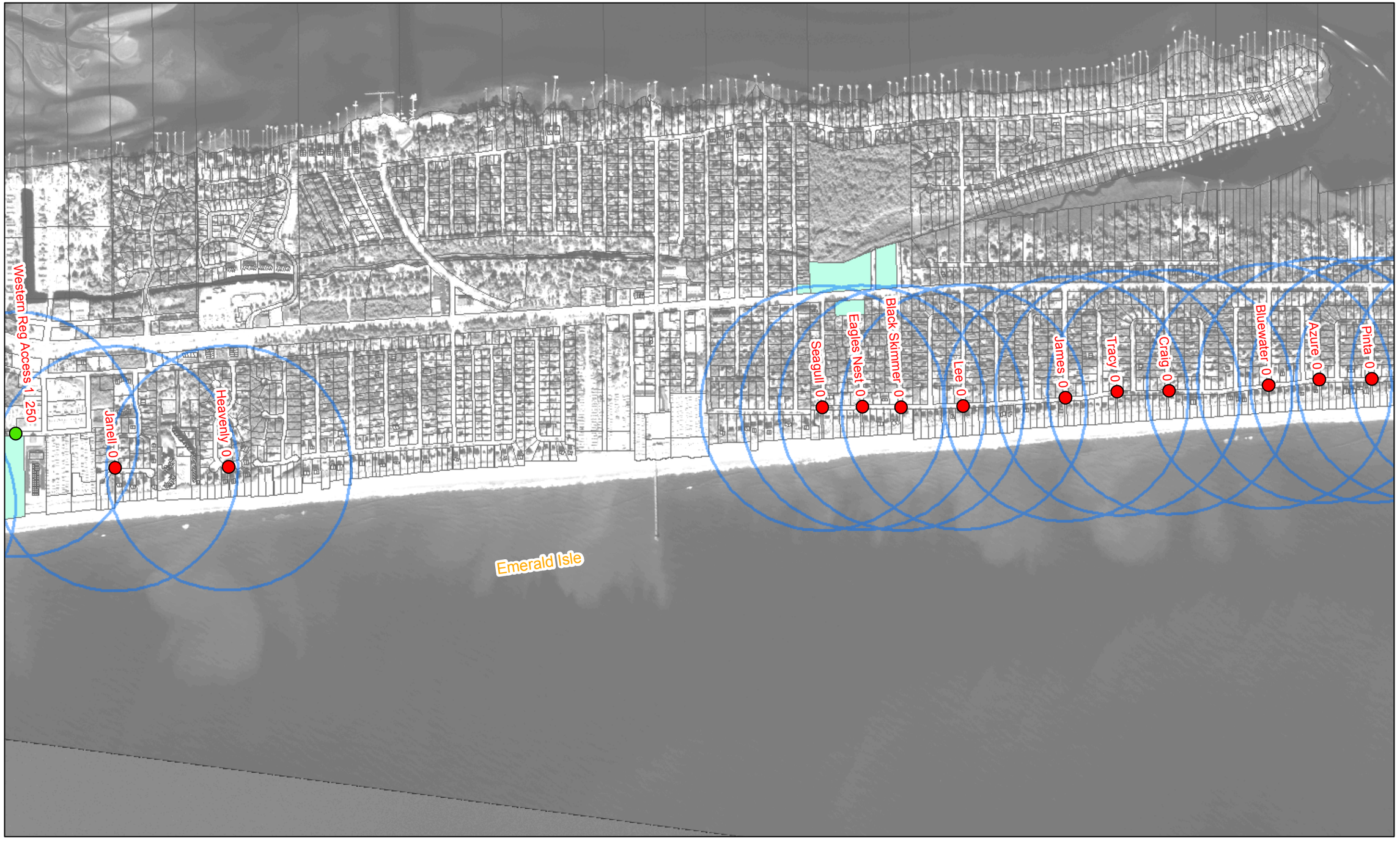
Parking Radius 1/4 Mile
Town Properties
Carteret Tax Parcels 2010

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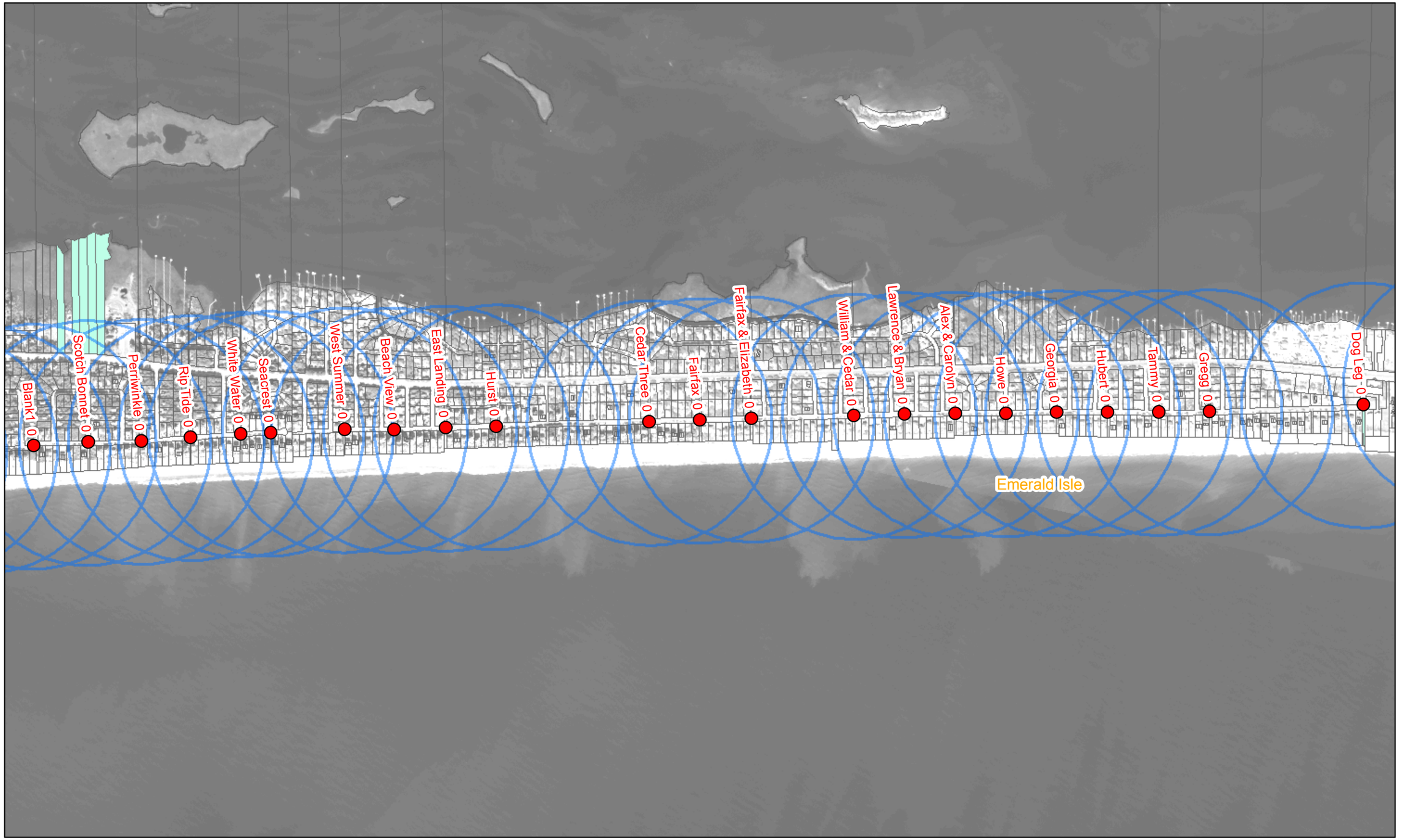


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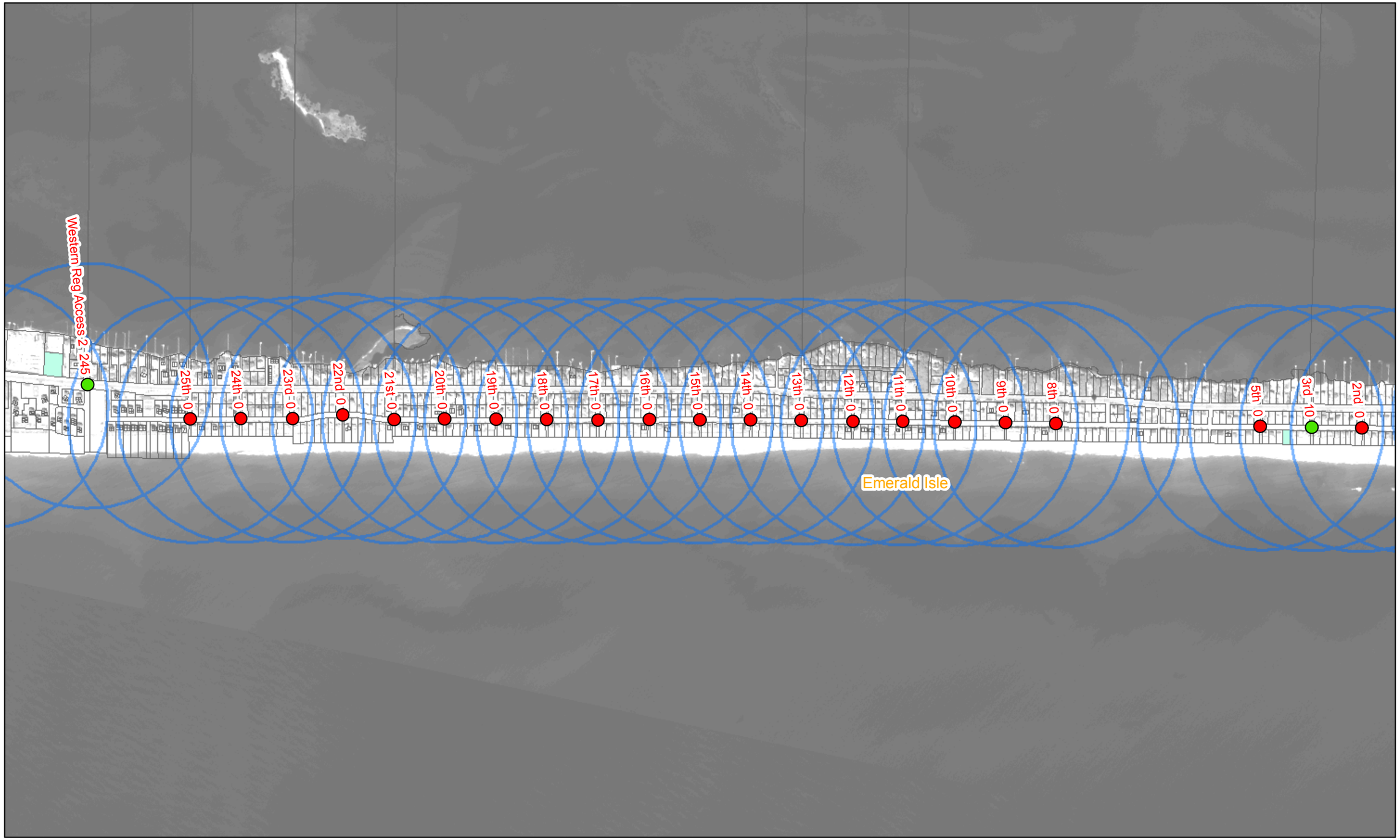


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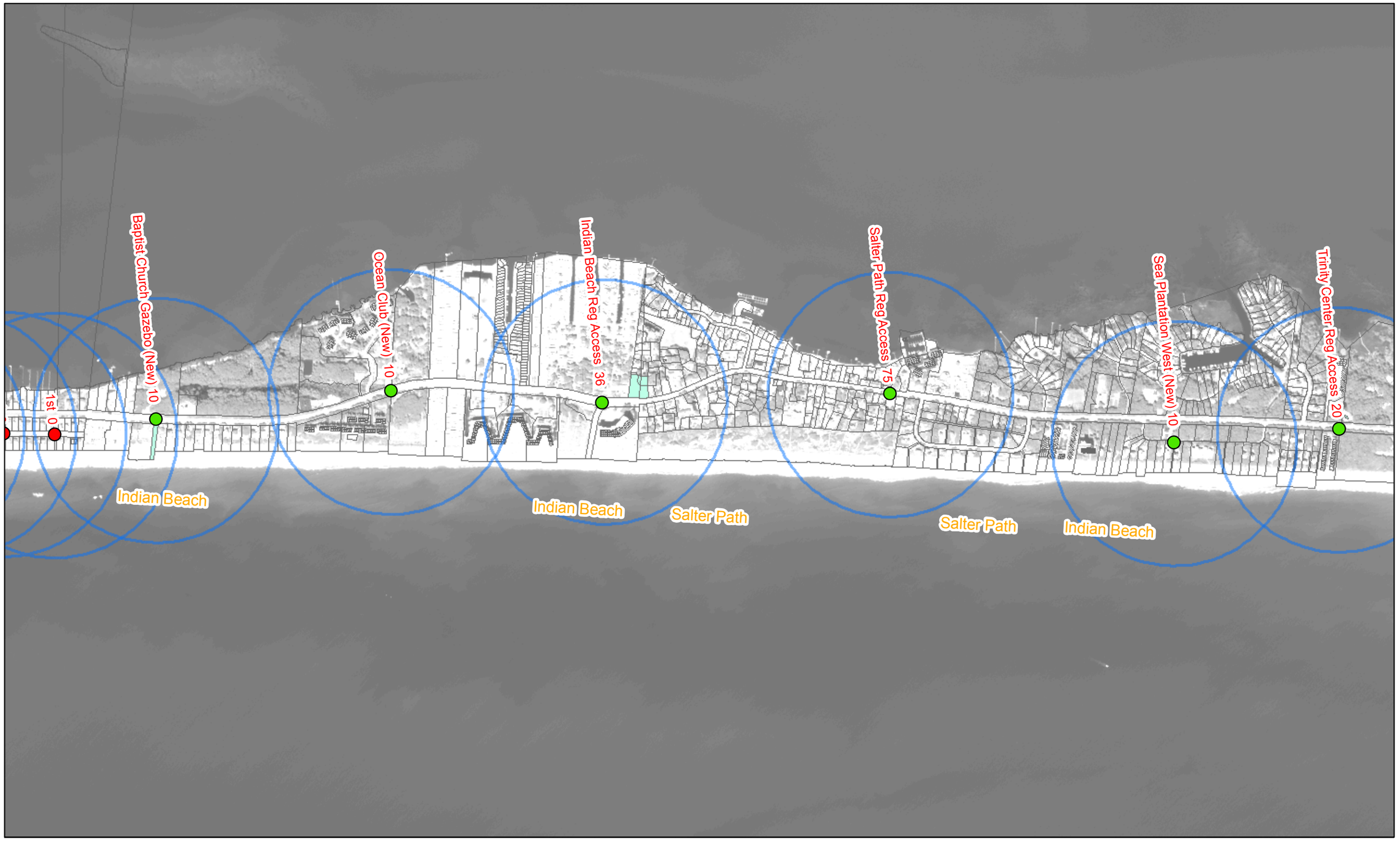


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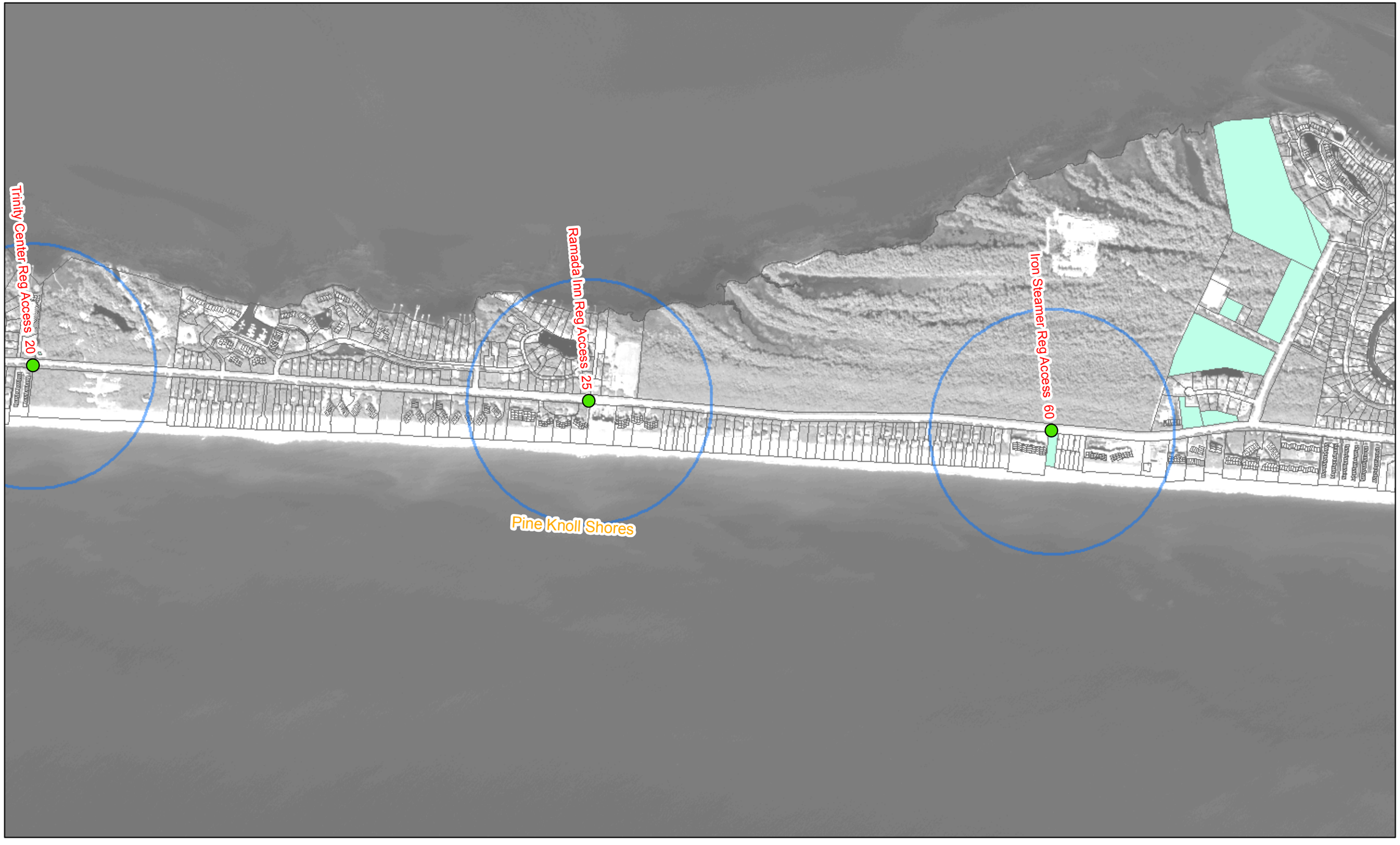


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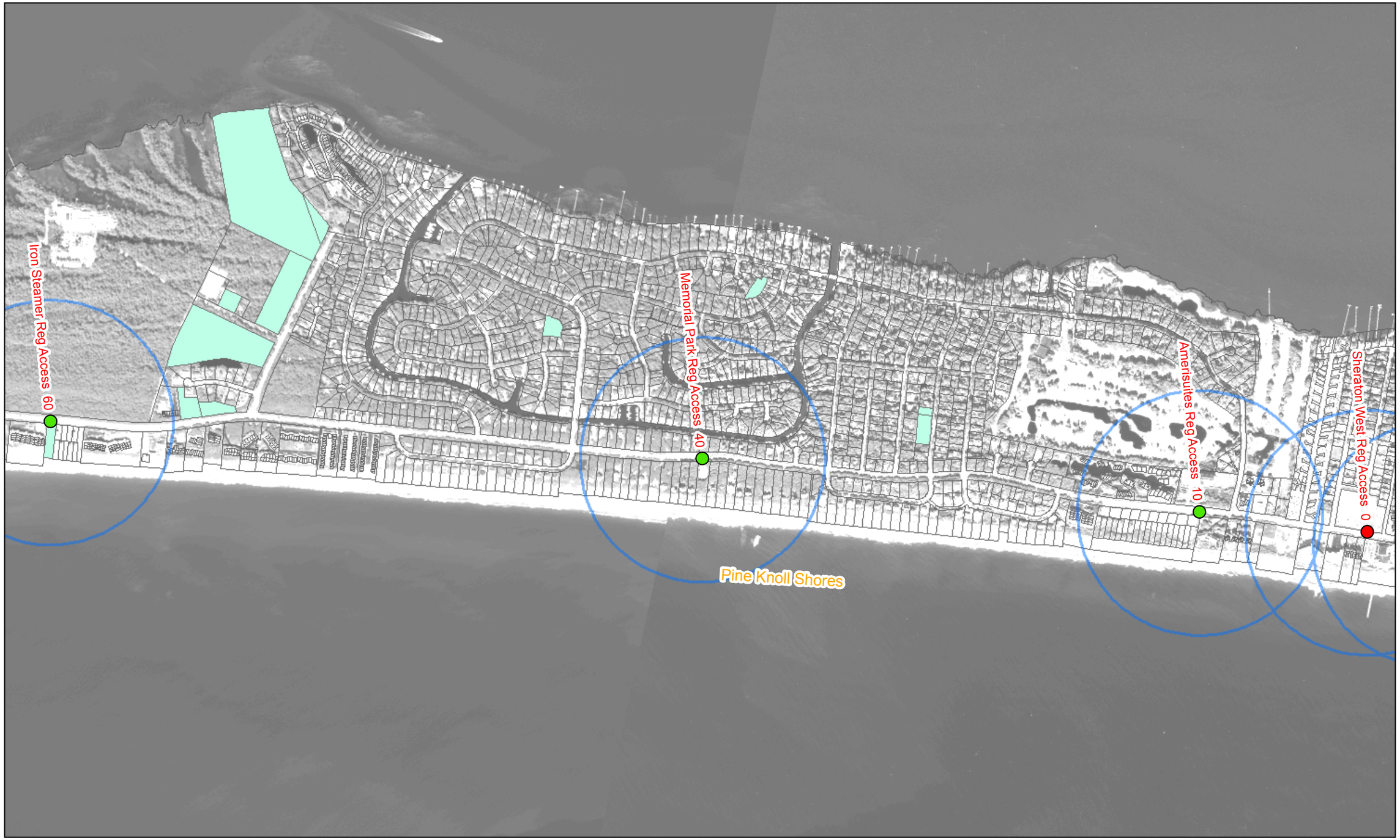


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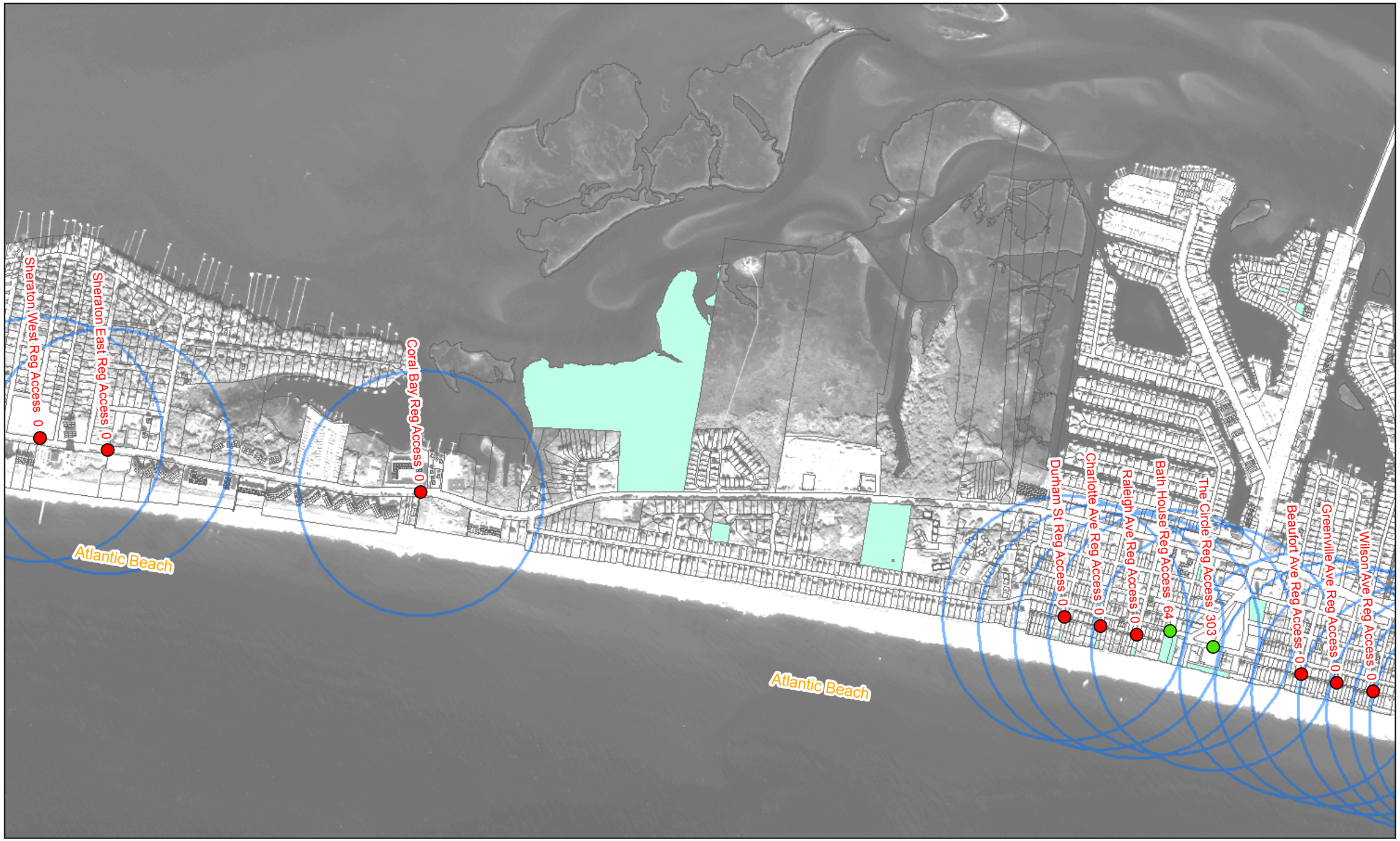


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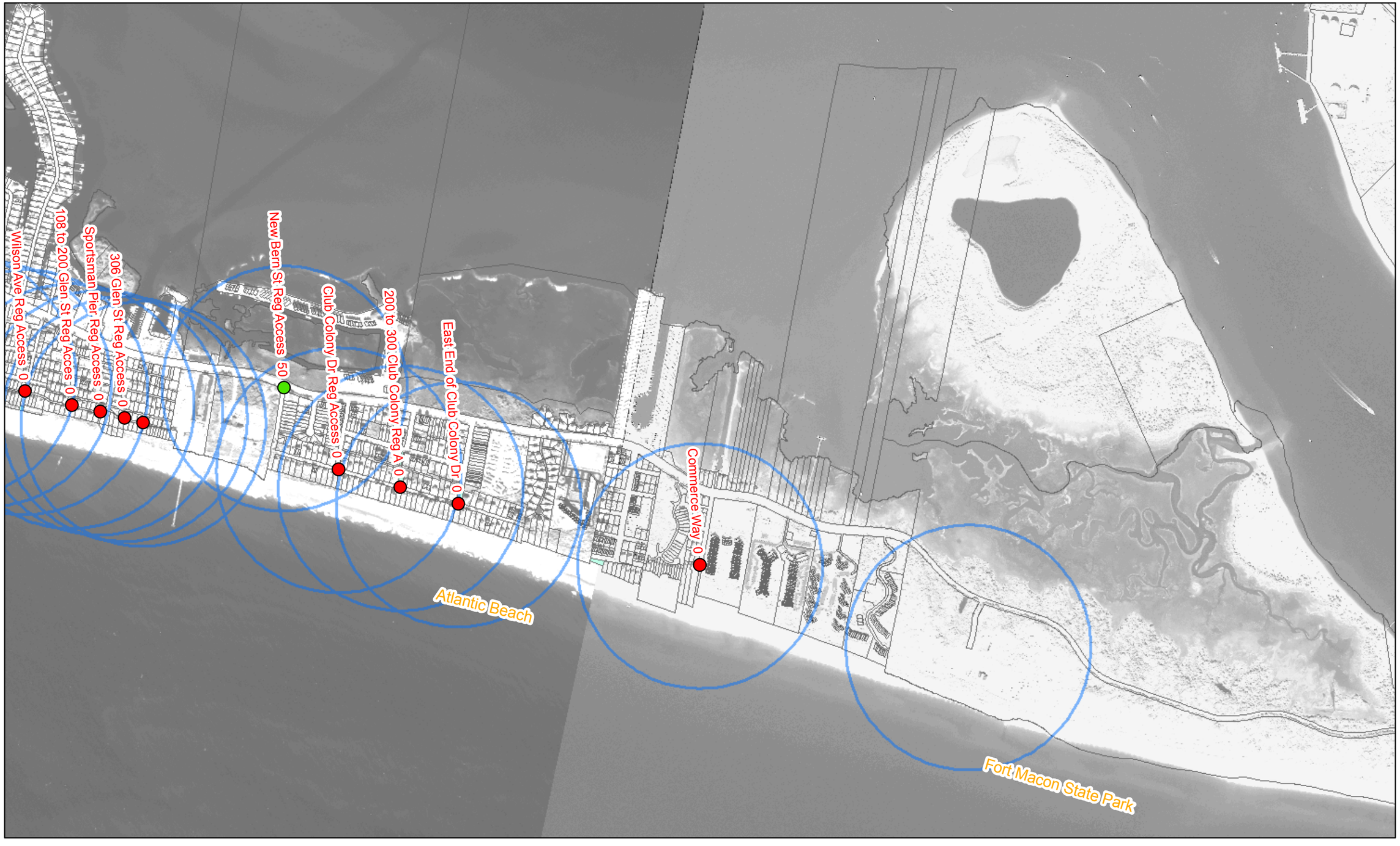


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Wilmington District

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Beach Access/Parking Assessment

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- 10 or More Parking Spaces

Parking Radius 1/4 Mile
Town Properties
Carteret Tax Parcels 2010

# ATTACHMENT 3

# PEAK PARKING ANALYSIS – DETAILED METHODOLOGY

## Introduction

This attachment provides an overview of the data and methodology that was used to determine the peak parking space requirements. The data on which the analysis is based comes the from telephone and onsite surveys conducted by the University of North Carolina at Wilmington in 2003 (the full report can be made available upon request). This data was used to establish parking requirements for Bogue Banks at the estimated start of project construction.

## Methodology

The telephone survey asked respondents about trips taken in a 120-mile radius of the North Carolina coast during a typical peak summer season. The data was used to construct an index of the number of recreational day trip (TRIPINDX) to a beach. $TRIPINDX_i$ is the estimated number of recreational day trips taken to beach i per year by 1,067 households in the telephone survey sample. PC Miler, a Poisson/negative-binomial cluster regression model, was used to generate TRIPINDX. Other data collected for this study include stay time, STAYTIME, which is the average length of time in hours that a visitor remained at the beach. The duration of stay is assumed to affect parking demand. If the duration of stay is usually long, more parking spaces should be provided.

The on-site survey collected parking space data for ten beaches on peak (weekend) days in July and August 2003. For this analysis the variable $SPACES_,$ which gives the existing number of parking spaces at each beach, is used as a censoring variable by the Tobit regression procedure. Each beach has a separate censoring limit, as specified by the $SPACES_i$ variable. Two holidays were included in the survey effort: the Fourth of July weekend and the Labor Day Weekend. To test for the effect of holiday on parking demand, a dummy variable, $HOLIDAY_{d,}$ was generated equal to 1 if the day is July 4 or 5, or August 30 or 31, days corresponding to the Fourth of July and Labor Day holidays.

To account for fixed effects in the model, beach-specific dummy variables, DB00, DB09, that shift the intercept were generated for nine beaches. The dummy for beach 10 is omitted to avoid a dummy variable trap. Observe that beach 08 is omitted from the whole analysis. Dummy variables capturing time of day effects were constructed as follows: if t = 9am-11am, DMORN = 1, DMORN = 0 otherwise; if t = 3pm-5pm, DAFTN = 1, DAFTN = 0 otherwise. Note that potential dummy variable DMID = 1 when t = 12noon-2pm is omitted to avoid the dummy variable trap. Under this specification, with all dummy variables set to zero, the regression predicts uncensored FILLEDSP (dependent variable) at midday on a non-holiday weekend day on beach 10 (Atlantic Beach). Setting one of the various dummy variables to the value “1” adjusts the regression predictions for an alternative time of day or an alternative beach destination. Table A1 summarizes key statistics for the survey data sample.

| Variable | Description | Mean | Std.Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| FILLEDSP | Filled Parking Spaces | 2.5666 | 2.2871 | 0 | 9.09 |
| STAYTIME | Stay Time at beach | 4.339445 | 1.318575 | 0.1875 | 9.5 |
| HOLIDAY | Holiday {Fourth of July and Labor Day} | 0.532934 | 0.49929 | 0 | 1 |
| TRIPINDX | Trip index | 428.956 | 255.16 | 146 | 924 |
| DMORN | Day time dummy variable | 0.377246 | 0.48506 | 0 | 1 |
| DAFTN | Afternoon time dummy variable | 0.211078 | 0.408379 | 0 | 1 |
| DB00 | Caswell Beach | 0.0329 | 0.178598 | 0 | 1 |
| DB01 | Oak Island Beach | 0.0449 | 0.207262 | 0 | 1 |
| DB02 | Holden Beach | 0.0404 | 0.197088 | 0 | 1 |
| DB03 | North Topsail Beach | 0.0449 | 0.207262 | 0 | 1 |
| DB04 | Surf City Beach | 0.0404 | 0.197088 | 0 | 1 |
| DB05 | Topsail Beach | 0.0404 | 0.197088 | 0 | 1 |
| DB06 | Pine Knoll Shores Beach | 0.0389 | 0.193554 | 0 | 1 |
| DB08 | Indian Beach | 0.0404 | 0.197088 | 0 | 1 |
| DB09 | Emerald Isle Beach | 0.0434 | 0.203938 | 0 | 1 |

**Notes: Only** aggregate statistics are reported in table. The descriptive statistics for the 10 individual beaches are not presented to economize on space.

Table A1. Summary statistics of survey data.

It is likely that some visitors may not use the beach because parking capacity is limited. Suppose that out of 500 potential beach visitors, 200 are unable to use the beach because they cannot find parking space. One strategy of dealing with this difficulty is to ignore or drop these observations from the sample. However, by eliminating this subset from the sample not only do we lose degrees of freedom and therefore precision, we also risk biased estimates of the effects of independent variables. That is, important factors correlated with the dependent variable may characterize this group of visitors that has been dropped. In situations such as these, a better strategy that allows use of the entire sample is to assume that the dependent variable FILLEDSP (number of parking spaces filled at a give beach) has a censored distribution; that is, the dependent variable cannot be observed above or below some threshold value, and therefore is reported as this threshold value.

The underlying model of censored regression assumes that the true value of the dependent variable is unobservable. The basic form of the censored regression model is given by the latent variable formulation:

$$Y_i^* = X'_i\beta + \varepsilon_i \qquad (1)$$

*Where* $y_i^*$ *is the latent variable,* $X'_i$ *is a vector of exogenous variables and* $\varepsilon_i$ *is a normal error term with zero mean and standard deviation* $\sigma$ *.*

*Define the censored random variable* $Y_i$ *as*

$$y_i = o \ \ if \ \ y_i^* \leq 0$$
$$y_i = y^*_i \ \ if \ \ y_i^* \succ 0$$

The dependent variable of the censored regression model is observed when $y_i^* \succ 0$. With the survey we can obtain the observable response ($y_i$) which represents the unobservable outcome of a particular range.

When the range of dependent variable is limited, censored regression methodology are used to analyze the data. Given the censored nature of the dependent variable, performing OLS on equation (1) will result in inconsistent coefficient estimates. To account for censored dependent variable and to obtain consistent estimates of the parameters, we estimate a censored regression within a maximum likelihood Tobit model.

The Tobit regression model (with upper and lower tail censoring) is specified as:

$$Ln(FILLEDSP_{idt}) = \beta_o + \beta_1 DMORN + \beta_2 DAFTN + \beta_3 DB00 + ...\beta_{11} DB09 + \beta_{12} STAYTIME_{id} + \beta_{13} HOLIDAY_d + \beta_{14} TRIPINDX_i + e_{idt} \quad (2)$$

If $\text{Ln}(FILLEDSP_{idt}) \leq 0$, then $\text{Ln}(FILLEDSP_{idt}) = 0$,
If $\text{Ln}(FILLEDSP_{idt}) \geq \text{In}(SPACES_i)$, then $\text{In}((FILLEDSP_{idt}) = (SPACES_i)$,

where:

FILLEDSP, STAYTIME, SPACES, HOLIDAY, DMORN, DAFTN, DB00…DB9, and TRIPINDX are variables defined above, $e_{idt}$ is a heteroskedastic error term. The error term is specified as $e_{idt} \sim N(0, \sigma^2.\exp(\alpha.TRIPIND_i))$, where $\sigma$ (the standard deviation of the uncensored dependent variable in the absence of heteroskedasticity), $\alpha$ and $\beta_0 - \beta_{14}$ are the parameters to be estimated.

Parameters of the distribution of the latent dependent variable are estimated by maximum likelihood in LIMDEP (2002). The Tobit regression model estimates the probability distribution of FILLEDSP, including the number of FILLEDSP that would occur if the number of parking spaces were not constrained. The resulting probability distribution can be used to estimate parking requirements beyond current parking space capacity.

**Results:**

Projected Annual Visitation

As state population increases, the number of visitors to Bogue Banks is expected to increase, assuming that the number of trips per household remains constant. Table A1 shows baseline annual visitation to each of the towns in future years, as well as with various changes in beach width.

| Year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NC State Gov't projections of households in telephone survey area | 1,800,076 | 1,826,960 | 1,854,353 | 1,881,535 | 1,929,183 | 1,957,774 | 1,987,225 | 2,016,205 | 2,042,055 | 2,068,172 | 2,094,974 |
| **EMERALD ISLE** | | | | | | | | | | | |
| Baseline Trips to this beach | 986,726 | 1,001,463 | 1,016,478 | 1,031,378 | 1,057,497 | 1,073,169 | 1,089,314 | 1,105,199 | 1,119,369 | 1,133,685 | 1,148,377 |
| Trips w. -50 width | 875,400 | 888,474 | 901,796 | 915,015 | 938,186 | 952,091 | 966,413 | 980,506 | 993,078 | 1,005,779 | 1,018,813 |
| Trips w. +50 width | 1,112,210 | 1,128,820 | 1,145,745 | 1,162,540 | 1,191,980 | 1,209,646 | 1,227,843 | 1,245,749 | 1,261,721 | 1,277,858 | 1,294,417 |
| Trips w. +100 width | 1,253,651 | 1,272,374 | 1,291,452 | 1,310,382 | 1,343,566 | 1,363,478 | 1,383,990 | 1,404,172 | 1,422,176 | 1,440,365 | 1,459,030 |
| Trips w. +150 width | 1,413,080 | 1,434,184 | 1,455,687 | 1,477,026 | 1,514,430 | 1,536,874 | 1,559,994 | 1,582,743 | 1,603,036 | 1,623,538 | 1,644,578 |
| **INDIAN BEACH & SALTER PATH** | | | | | | | | | | | |
| Baseline Trips to this beach | 158,483 | 160,850 | 163,262 | 165,655 | 169,850 | 172,367 | 174,960 | 177,512 | 179,788 | 182,087 | 184,447 |
| Trips w. -50 width | 140,603 | 142,703 | 144,842 | 146,965 | 150,687 | 152,920 | 155,221 | 157,484 | 159,504 | 161,543 | 163,637 |
| Trips w. +50 width | 178,638 | 181,306 | 184,024 | 186,722 | 191,450 | 194,288 | 197,210 | 200,086 | 202,652 | 205,244 | 207,903 |
| Trips w. +100 width | 201,356 | 204,363 | 207,427 | 210,468 | 215,797 | 218,996 | 222,290 | 225,532 | 228,423 | 231,345 | 234,343 |
| Trips w. +150 width | 226,962 | 230,352 | 233,806 | 237,233 | 243,241 | 246,846 | 250,559 | 254,213 | 257,472 | 260,765 | 264,144 |
| **PINE KNOLL SHORES** | | | | | | | | | | | |
| Baseline Trips to this beach | 193,522 | 196,412 | 199,357 | 202,279 | 207,401 | 210,475 | 213,641 | 216,757 | 219,536 | 222,344 | 225,225 |
| Trips w. -50 width | 171,688 | 174,252 | 176,865 | 179,457 | 184,002 | 186,729 | 189,538 | 192,302 | 194,767 | 197,258 | 199,814 |
| Trips w. +50 width | 218,132 | 221,390 | 224,709 | 228,003 | 233,777 | 237,242 | 240,811 | 244,322 | 247,455 | 250,620 | 253,867 |
| Trips w. +100 width | 245,872 | 249,544 | 253,286 | 256,999 | 263,507 | 267,412 | 271,435 | 275,393 | 278,924 | 282,491 | 286,152 |
| Trips w. +150 width | 277,140 | 281,279 | 285,496 | 289,681 | 297,017 | 301,419 | 305,954 | 310,415 | 314,395 | 318,416 | 322,543 |
| **ATLANTIC BEACH** | | | | | | | | | | | |
| Baseline Trips to this beach | 871,446 | 884,461 | 897,722 | 910,881 | 933,949 | 947,790 | 962,048 | 976,077 | 988,592 | 1,001,236 | 1,014,211 |
| Trips w. -50 width | 773,126 | 784,673 | 796,438 | 808,113 | 828,577 | 840,857 | 853,506 | 865,953 | 877,055 | 888,273 | 899,784 |
| Trips w. +50 width | 982,269 | 996,939 | 1,011,887 | 1,026,720 | 1,052,720 | 1,068,322 | 1,084,393 | 1,100,207 | 1,114,313 | 1,128,564 | 1,143,189 |
| Trips w. +100 width | 1,107,186 | 1,123,722 | 1,140,570 | 1,157,289 | 1,186,596 | 1,204,182 | 1,222,297 | 1,240,122 | 1,256,021 | 1,272,085 | 1,288,571 |
| Trips w. +150 width | 1,247,988 | 1,266,627 | 1,285,618 | 1,304,463 | 1,337,497 | 1,357,319 | 1,377,738 | 1,397,830 | 1,415,752 | 1,433,858 | 1,452,440 |

Table A1. Projected annual visitation at Bogue Banks communities.

Total visits include both day and overnight visitors. For instance, about 52% of the visitation at Atlantic Beach is from day visitors, as compared to about 35% of the visitation at Emerald Isle. This leads to greater peak parking needs at Atlantic Beach, despite there being more overall visitation at Emerald Isle.

Projected Parking Needs

Estimates of the beach parking demand model using the two-limit Tobit regression estimation procedure is shown in Table A2.

| Explanatory Variables | Coefficient | Std. Error. | t-ratio | P-value | Mean |
|---|---|---|---|---|---|
| Constant | 4.557*** | 0.506 | 9.00 | 0 | 1 |
| DMORN | -0.666 | 0.488 | -1.36 | 0.1727 | 0.3772 |
| DAFTN | -0.307 | 0.490 | -0.63 | 0.5311 | 0.2111 |
| DB00 | -0.518 | 0.567 | -0.92 | 0.3601 | 0.0329 |
| DB01 | 0.699 | 0.512 | 1.37 | 0.1723 | 0.0449 |
| DB02 | -0.379 | 0.527 | -0.719 | 0.4722 | 0.0404 |
| DB03 | 0.166 | 0.595 | 0.279 | 0.7803 | 0.0449 |

| | | | | | |
|---|---|---|---|---|---|
| DB04 | -0.706 | 0.564 | -1.252 | 0.2105 | 0.0404 |
| DB05 | -0.101 | 0.543 | -0.186 | 0.8521 | 0.0404 |
| DB06 | -0.262 | 0.5577 | -0.47 | 0.6383 | 0.0389 |
| DB07 | -0.946* | 0.5378 | -1.76 | 0.0785 | 0.0404 |
| DB09 | -1.271** | 0.5544 | -2.293 | 0.0218 | 0.0434 |
| STAYTIME | 0.008 | 0.0206 | 0.362 | 0.7175 | 4.339 |
| HOLIDAY | 0.364*** | 0.0536 | 6.78 | 0 | 0.5329 |
| TRIPINDX | 0.003*** | 0.00018 | 12.6 | 0 | 428.656 |
| Sigma | 0.451*** | 0.0161 | 28.023 | 0 | ---- |
| Alpha | 0.0007*** | 0.000067 | 10.992 | 0 | ---- |
| Log-likelihood | -623.66 | | | | |

Notes: ***,**, and * refer to significance at the 1%, 5%, and 10% levels, respectively. The chi-square and overall likelihood ratio statistics are 29.1 and 546.7, respectively. Number of observations =699. Dependent variable: FILLEDSP. D13 is the omitted time of day dummy variable.

Table A2. Tobit regression results - Dependent Variable: FILLEDSP

As expected the coefficient on the beach specific index of recreation demand, TRIPINDX, is positive and strongly significant. The large t statistic, 12.6, allows us to reject the null hypothesis of no trip demand at the 1% level of significance. This provides evidence that beach trip demand impacts the number of parking spaces. The heteroskedasticity parameter $\alpha$ is positive and strongly significant, indicating that larger values of TRIPINDX increase the variance of ln(FILLEDSP). There is evidence to indicate that HOLIDAY has a positive and significant effect on filled spaces. We also find evidence that STAYTIME has a positive but insignificant effect on filled spaces. Fixed effects dummy variables DB00…DB09 vary in sign, reflecting differences in the estimated value of filled parking spaces, ln(FILLEDSP), at midday across beaches. However, after controlling for other variables in the regression, only DB07 and DB09 are statistically significant at the 10% and 5% level, respectively. There is no evidence to indicate that this data suggests that time of day variables, DMORN and DAFTN, significantly impact beach-parking demand. In all, the explanatory power of the regression is reasonably good given the individual cross section data. The likelihood ratio test indicates that the overall regression is significant at $p<0.01$.

As mentioned earlier, an important component of this analysis was to determine parking spaces that would be required to accommodate all peak (weekend holiday) day beach visitors. With the estimated Tobit coefficients, it is possible to calculate the number of spaces that would be required to accommodate all peak (weekend holiday) day beach visitors 60% of the time, 95% of the time, etc. For each beach, ln(FILLEDSP) follows a normal distribution, with a beach-specific mean value given by the Tobit regression equation (with variables replaced by their mean values), and a beach-specific standard deviation given by $(\sigma^2 \cdot \exp[\alpha \cdot \text{TRIPINDX}_i])^{0.5}$. The unconditional mean of $\ln(\text{FILLEDSP}_i)$, denoted $\bar{\mu}$, is given by: $\bar{\mu} = \beta_0 + \beta_1$ DMORN + $\beta_2$ DAFTN + $\beta_3$ DB00 + . . . + $\beta_{11}$ DB09 + $\beta_{12}$ $\text{STAYTIME}_{id}$ + $\beta_{13}$ $\text{HOLIDAY}_d$ + $\beta_{14}$ $\text{TRIPINDX}_i$,

where mean values are inserted for independent variables. The standard deviation of $\ln(\text{FILLEDSP}_i)$, denoted SD, is given by: $\text{SD} = \sigma^2 \cdot \exp[\alpha \cdot \text{TRIPINDX}_i])^{0.5}$. The unconditional

90 percentile, for example, of $FILLEDSP_i$ is then given by: 90 percentile $FILLEDSP_i$ = EXP(NORMINV(0.90, $\bar{\mu}$, SD)), where NORMINV is the inverse normal cumulative distribution function.

For each beach, the frequency of FILLEDSP can be graphed against FILLEDSP to determine the number of spaces that would be necessary to accommodate all peak (weekend holiday) day beach visitors 60% of the time, 95% of the time, etc. Furthermore, changes in beach conditions may shift the frequency distribution of FILLEDSP. An increase in beach width attracts additional beach visitation, which shifts the frequency distribution to the right. As the distribution shifts to the right, the current number of parking spaces accommodates all visitors less frequently.

Tables A3-A6 shows the number of parking spaces needed to meet peak demand at each of the Bogue Banks communities 60%, 70%, 80%, 90% and 95% of the time at future years with the various beach width increases associated with the tentatively selected plan.

The average change in beach width at each of the communities, as compared to the without project condition, is as follows:

Emerald Isle: +6 ft
Salter Path and Indian Beach: +26 ft
Pine Knoll Shores: +21 ft
Atlantic Beach: +54 ft

The project year of project construction is 2019. Having sufficient parking to meet peak demand 60% of the time at the start of project construction is considered sufficient for satisfying the USACE requirement for accommodating peak demand.

| | USACE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Telephone Survey | | | | EMERALD ISLE Parking Space Requirements, with +6 ft beach width | | | | | | |
| | Region | | | | | | | | | |
| | Population | | | | | | | | | |
| | Index | | Mean | Std. Dev. | Mean | 60%tile | 70%tile | 80%tile | 90%tile | 95%tile |
| Year | (2004 Base) | TRIPINDX | ln(FILLEDSP) | ln(FILLEDSP) | FILLEDSP | 0.6 | 0.7 | 0.8 | 0.9 | 0.95 |
| 2013 | 1.142909226 | 1072 | 6.11E+00 | 0.674463107 | 448 | 532 | 638 | 791 | 1064 | 1359 |
| 2014 | 1.158993672 | 1087 | 6.14E+00 | 0.678298367 | 464 | 551 | 662 | 821 | 1106 | 1415 |
| 2015 | 1.175403086 | 1103 | 6.17E+00 | 0.682233588 | 480 | 571 | 687 | 853 | 1151 | 1475 |
| 2016 | 1.191880291 | 1118 | 6.21E+00 | 0.686208039 | 497 | 592 | 713 | 886 | 1198 | 1538 |
| 2017 | 1.208539311 | 1134 | 6.24E+00 | 0.690249885 | 515 | 614 | 740 | 921 | 1248 | 1604 |
| 2018 | 1.225643369 | 1150 | 6.28E+00 | 0.694424477 | 534 | 637 | 769 | 959 | 1301 | 1674 |
| 2019 | 1.243302456 | 1166 | 6.32E+00 | 0.698761028 | 555 | 662 | 800 | 999 | 1358 | 1751 |
| 2020 | 1.260632105 | 1182 | 6.36E+00 | 0.703043004 | 575 | 688 | 832 | 1040 | 1417 | 1829 |
| 2021 | 1.275861877 | 1197 | 6.39E+00 | 0.706827781 | 594 | 711 | 861 | 1077 | 1470 | 1901 |
| 2022 | 1.291205705 | 1211 | 6.42E+00 | 0.710661507 | 614 | 735 | 891 | 1117 | 1527 | 1976 |
| 2023 | 1.306920061 | 1226 | 6.45E+00 | 0.714609364 | 635 | 761 | 923 | 1158 | 1586 | 2057 |

Table A3. Peak parking demand requirements for +6 ft beach width at Emerald Isle.

| | USACE Telephone Survey Region Population Index | | INDIAN BEACH & SALTE irements, with +26 ft beach width | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | (2004 Base) | TRIPINDX | Mean ln(FILLEDSP) | Std. Dev. ln(FILLEDSP) | Mean FILLEDSP | 60%tile 0.6 | 70%tile 0.7 | 80%tile 0.8 | 90%tile 0.9 | 95%tile 0.95 |
| 2013 | 1.142909226 | 181 | 4.41E+00 | 0.482447833 | 82 | 93 | 106 | 123 | 153 | 182 |
| 2014 | 1.158993672 | 183 | 4.42E+00 | 0.482908849 | 83 | 93 | 107 | 124 | 154 | 183 |
| 2015 | 1.175403086 | 186 | 4.42E+00 | 0.483379634 | 83 | 94 | 107 | 125 | 155 | 184 |
| 2016 | 1.191880291 | 188 | 4.43E+00 | 0.483852826 | 84 | 95 | 108 | 126 | 156 | 185 |
| 2017 | 1.208539311 | 191 | 4.43E+00 | 0.48433171 | 84 | 95 | 109 | 127 | 157 | 187 |
| 2018 | 1.225643369 | 194 | 4.44E+00 | 0.484823881 | 85 | 96 | 109 | 127 | 158 | 188 |
| 2019 | 1.243302456 | 196 | 4.45E+00 | 0.485332547 | 85 | 96 | 110 | 128 | 159 | 189 |
| 2020 | 1.260632105 | 199 | 4.45E+00 | 0.485832242 | 86 | 97 | 111 | 129 | 160 | 191 |
| 2021 | 1.275861877 | 202 | 4.46E+00 | 0.486271813 | 86 | 98 | 111 | 130 | 161 | 192 |
| 2022 | 1.291205705 | 204 | 4.46E+00 | 0.486715078 | 87 | 98 | 112 | 131 | 162 | 193 |
| 2023 | 1.306920061 | 206 | 4.47E+00 | 0.487169466 | 87 | 99 | 113 | 131 | 163 | 194 |

Table A4. Peak parking demand requirements for +26 ft beach width at Indian Beach and Salter Path.

| | USACE Telephone Survey Region Population Index | | PINE KNOLL SHORES Parking Space Requirements, with +21 ft beach width | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | (2004 Base) | TRIPINDX | Mean ln(FILLEDSP) | Std. Dev. ln(FILLEDSP) | Mean FILLEDSP | 60%tile 0.6 | 70%tile 0.7 | 80%tile 0.8 | 90%tile 0.9 | 95%tile 0.95 |
| 2013 | 1.142909226 | 218 | 5.18E+00 | 0.489335203 | 178 | 201 | 230 | 268 | 333 | 398 |
| 2014 | 1.158993672 | 221 | 5.19E+00 | 0.489900521 | 179 | 203 | 232 | 270 | 335 | 401 |
| 2015 | 1.175403086 | 225 | 5.19E+00 | 0.490477933 | 180 | 204 | 233 | 273 | 338 | 404 |
| 2016 | 1.191880291 | 228 | 5.20E+00 | 0.491058415 | 182 | 206 | 235 | 275 | 341 | 407 |
| 2017 | 1.208539311 | 231 | 5.21E+00 | 0.491646001 | 183 | 207 | 237 | 277 | 344 | 411 |
| 2018 | 1.225643369 | 234 | 5.22E+00 | 0.492250016 | 184 | 209 | 239 | 279 | 346 | 414 |
| 2019 | 1.243302456 | 237 | 5.22E+00 | 0.492874409 | 186 | 210 | 240 | 281 | 349 | 418 |
| 2020 | 1.260632105 | 241 | 5.23E+00 | 0.493487925 | 187 | 212 | 242 | 283 | 352 | 421 |
| 2021 | 1.275861877 | 244 | 5.24E+00 | 0.494027729 | 188 | 213 | 244 | 285 | 355 | 424 |
| 2022 | 1.291205705 | 247 | 5.24E+00 | 0.494572173 | 190 | 215 | 246 | 287 | 357 | 428 |
| 2023 | 1.306920061 | 250 | 5.25E+00 | 0.495130387 | 191 | 216 | 247 | 290 | 360 | 431 |

Table A5. Peak parking demand requirements for +21 ft beach width at Pine Knoll Shores.

| | USACE Telephone Survey Region Population Index | | ATLANTIC BEACH Parking Space Requirements, with +54 ft beach width | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | (2004 Base) | TRIPINDX | Mean ln(FILLEDSP) | Std. Dev. ln(FILLEDSP) | Mean FILLEDSP | 60%tile 0.6 | 70%tile 0.7 | 80%tile 0.8 | 90%tile 0.9 | 95%tile 0.95 |
| 2013 | 1.142909226 | 1062 | 7.35E+00 | 0.671860737 | 1563 | 1854 | 2224 | 2752 | 3698 | 4721 |
| 2014 | 1.158993672 | 1077 | 7.39E+00 | 0.675644439 | 1617 | 1919 | 2305 | 2856 | 3844 | 4914 |
| 2015 | 1.175403086 | 1092 | 7.42E+00 | 0.679526545 | 1674 | 1988 | 2391 | 2966 | 3999 | 5119 |
| 2016 | 1.191880291 | 1107 | 7.46E+00 | 0.683447134 | 1733 | 2060 | 2480 | 3080 | 4161 | 5333 |
| 2017 | 1.208539311 | 1123 | 7.49E+00 | 0.68743398 | 1795 | 2136 | 2574 | 3201 | 4331 | 5560 |
| 2018 | 1.225643369 | 1139 | 7.53E+00 | 0.691551531 | 1860 | 2217 | 2674 | 3329 | 4513 | 5802 |
| 2019 | 1.243302456 | 1155 | 7.57E+00 | 0.695828576 | 1931 | 2303 | 2781 | 3468 | 4710 | 6064 |
| 2020 | 1.260632105 | 1171 | 7.60E+00 | 0.700051546 | 2002 | 2391 | 2890 | 3609 | 4911 | 6333 |
| 2021 | 1.275861877 | 1185 | 7.63E+00 | 0.703783963 | 2067 | 2471 | 2990 | 3738 | 5095 | 6579 |
| 2022 | 1.291205705 | 1200 | 7.67E+00 | 0.707564455 | 2135 | 2554 | 3094 | 3873 | 5287 | 6837 |
| 2023 | 1.306920061 | 1214 | 7.70E+00 | 0.71145729 | 2207 | 2643 | 3205 | 4016 | 5492 | 7112 |

Table A6. Peak parking demand requirements for +54 ft beach width at Atlantic Beach.

To summarize, the number of spaces needed to meet peak demand with the project in place is as follows:

Emerald Isle: 662 spaces
Salter Path and Indian Beach: 96 spaces
Pine Knoll Shores: 210 spaces
Atlantic Beach: 2,303 spaces
Total: 3,271 spaces